Power Supply Monitor and Control Board

Hardware Design Specification

Summary

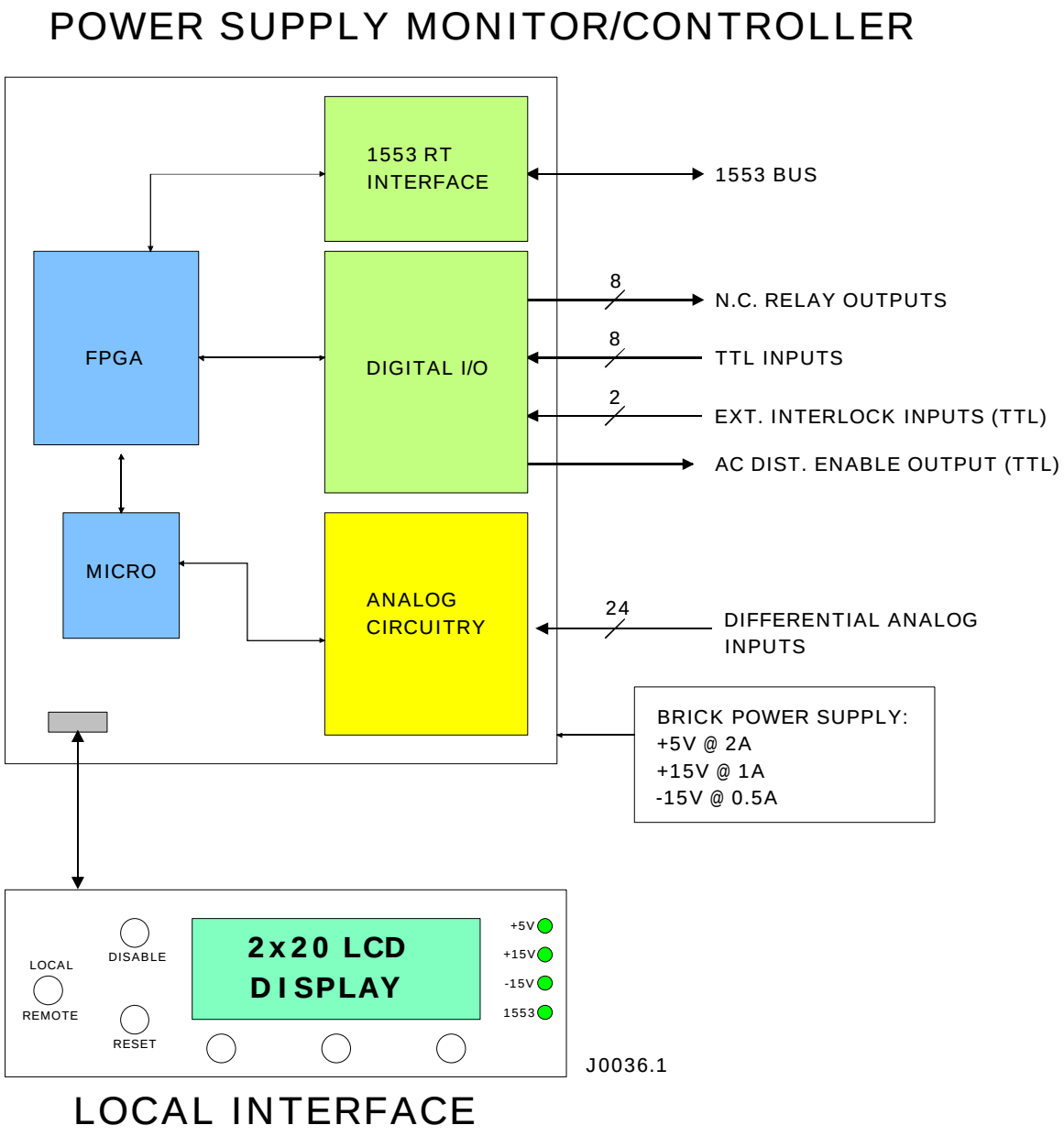
This document outlines the hardware specifications for a generic Power Supply Monitor/Controller Board to be used for the DFE and SEQUENCER power supplies on the center platform. The architecture of this board is based around a programmable logic device and a microcontroller and thus is very flexible and can be used in many different power supply applications.

Each of these different applications will require modifications to the software running on the microcontroller and this will change the way this device appears to the outside world. Rather than attempt to define an all-encompassing set of software registers and commands, this document only describes the hardware capabilities of this board. Refer to application-specific documentation for software registers definitions and local interface menus and examples.

Features

- ?? Integrated 1553 remote-terminal circuitry – does not require an external rack monitor.
- ?? 24 differential analog voltage inputs.
- ?? 10-bit ADC resolution on all analog input channels.
- ?? 8 opto-isolated TTL inputs.
- ?? 8 opto-isolated normally closed contract-closure outputs.
- ?? 2 Opto-isolated external interlock inputs.
- ?? 1 TTL output used to control AC distribution to supplies.
- ?? Support for character-based liquid crystal displays (LCD).
- ?? Trip thresholds can be set locally via LCD display or remotely via 1553.
- ?? Stores trip thresholds in Non-Volatile FLASH memory.
- ?? Microcontroller can average and filter analog voltage samples to prevent tripping on glitches or noise.
- ?? User can force each supply ON or OFF, and reset trips for each channel independently; either locally (using LCD menus) or remotely via 1553.
- ?? 6MHz RISC microcontroller, programmed in C or assembly language.
- ?? Watchdog timer shuts down supplies if the microcontroller or PLD malfunctions.
- ?? Board temperature sensor.

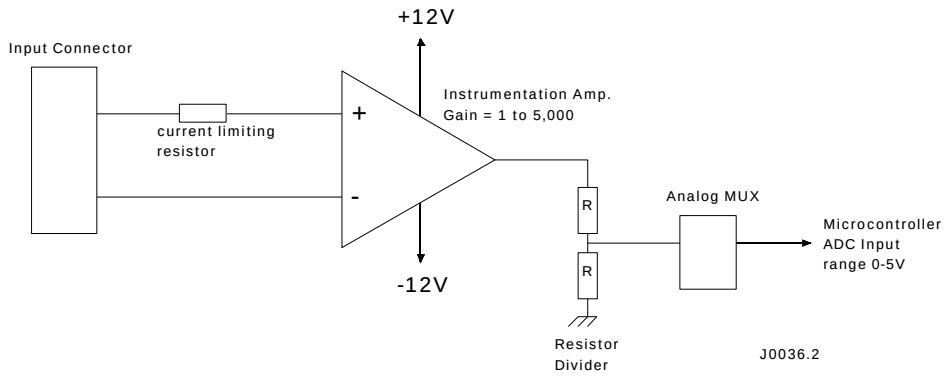
Block Diagram



Analog Inputs

Below is a diagram of a single analog input, there are 24 of these per board. By adjusting the gain the instrumentation amplifier it can be used as a voltage monitor or a current monitor (external shunt is required). Amplifier gain is set with a single resistor on the board; signal attenuation is achieved by using a resistor divider network on each analog input circuit.

- ?? Input voltages should be scaled (by the amplifier gain resistor and the voltage divider) so that the output from the voltage divider is always between 0 and +5V.
- ?? If an external shunt is used, the pickoff leads should be shielded to minimize noise.
- ?? Differential input voltage cannot exceed 12V.
- ?? Common Mode range for all inputs is +/- 10V.
- ?? The common mode rejection ratio (CMRR) is 80dB minimum.
- ?? All analog inputs can be sampled by the ADC at approximately 150Hz.



Digital I/O

Interlock Inputs. Two external interlock inputs are provided. These are opto-isolated. Logic driving these inputs must supply 1.7 to 5V @ 5-20mA – enough to drive an LED. There is a 220 ohm series resistor on the board. If either interlock is dropped (no voltage present) then the monitor/controller board will respond by turning off the AC Enable Output.

AC Enable Output. A single active-high TTL output is used to drive a solid state relay in the AC distribution box. If this output goes LOW the AC power to the supplies should be turned off. If either interlock input is dropped this output will go LOW. Additionally, this output can be controlled by the user from the local or remote interface.

Inputs. There are 8 opto-isolated TTL inputs on this board. Logic driving these inputs must supply 1.7 to 5V @ 5-20mA – enough to drive an LED. There is a 220 ohm series resistor on the board. These inputs are intended to be driven by the active-high "AC OK" signal from the power supplies.

Outputs. There are 8 normally closed opto-isolated contact closure outputs on this board. These are solid state relays with a closed resistance of approximately 25 ohms. They are intended to be connected to the Vicor GSD inputs and Vicor Signal GND. If the monitor/controller board is not powered up all supplies connected to the board will be disabled.

If an analog input exceeds its trip threshold the appropriate output relay will close, turning off the outputs of the corresponding power supply. The mapping between analog inputs and digital outputs is completely defined by the program running on the microcontroller.

WatchDog Timer

If the PLD malfunctions or the microcontroller hangs a **watchdog circuit** will close the output contacts, thus shorting the Vicor GSD input to Vicor signal GND and disabling the power supply outputs. To recover from a watchdog timeout error the monitor/control board must be hard reset from the Local Interface.

1553 Interface

The 1553 interface used here is similar to the one used on the AFE and DFE boards. Each board shows up as a single RT on the 1553 bus. All communication to this board occurs through a 256-word block of shared memory is accessed through two subaddreses:

Subaddr 16: The address pointer. Points to an address within the 256-word block of memory. Only the lower 8 bits are valid, the upper byte is ignored. This pointer automatically increments when data words are read from or written to the block of memory. The pointer will roll over to 0x00 after reaching 0xFF. This subaddr can be read and written at any time.

Subaddr 17: The data register. When read, returns the data in the memory location pointed to by the address pointer. When written to, overwrites the memory location pointed to by the address pointer. This subaddr can be read and written at any time.

Using these two subaddreses, the user can read and write any word in the block of shared memory. The following example outlines the steps needed to write (and verify) the words 0x1ACF, 0xFF7D, and 0xAA54 into memory locations 0x34, 0x35, 0x36.

1) Set the address pointer to 0x34 by writing one word (0x0034) to subaddr 16.
2) Write three words (0x1ACF, 0xFF7D, and 0xAA54) to subaddr 17. This can be done in a single 1553 write transaction.
3) Read back the address pointer by reading back subaddress 16. It should read 0x0037.
4) Reset the address pointer to 0x34 by writing one word (0x0034) to subaddress 16.
5) Read three words from subaddress 17. The words returned should be 0x1ACF, 0xFF7D, and 0xAA54.

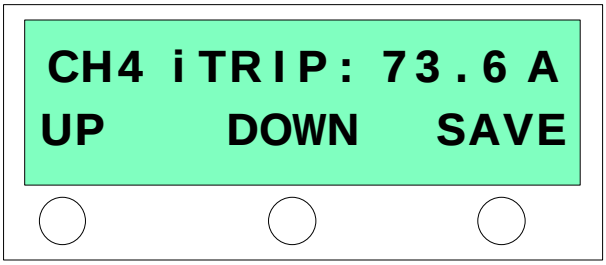
This engineering note deals only with the hardware functionality of the Power Supply Monitor and Control Board. The program running on the microcontroller determines the meaning of the bits and words contained in shared memory. Different applications will define this block of memory in different ways and this is not addressed here.

Local Interface

The local interface consists of the LCD display, a toggle switch, 5 pushbuttons, and some LEDs. All functions accessible via 1553 will also be accessible through this interface[1]. Four LEDs are provided: +5V, +15V, -15V, and 1553 activity. Switches and buttons are defined as follows:

1) Remote/Local toggle switch. When this board is placed in LOCAL mode status variables will continue to be updated in the 1553 interface, but control functions will only be available only through the LCD display.
2) Reset button – press to perform a soft reset of the microcontroller. Press and hold for 2 seconds to generate a hard reset of the PLD and microcontroller.
3) Output . Press this button at any time to disable the outputs of all supplies connected to the monitor/controller board.

There are three additional buttons used to navigate through the LCD display menus. These buttons change function depending on what menu the user is viewing. An example is shown below:



Other functions accessible through the Local Interface are determined by the microcontroller program and will vary depending on the application. These functions are not described in this document.

[1] The 1553 RT address can ONLY be accessed through the LCD user interface. The RT address is stored in non-volatile memory and becomes the power up default. It can be changed at any time.

Programming Interfaces

The main logic on this board consists of a Xilinx FPGA and an Atmel FLASH microcontroller. The FPGA is configured via a EEPROM on the board; both the FPGA and EEPROM are connected to JTAG chain for in-circuit programming. The Atmel microcontroller is also in-circuit programmable. Both programming interfaces are brought out to 10 pin headers on the board.

Board Mechanical

With the exception of the 1553 connectors which are soldered directly to the PCB, all connections to this board are through 0.1" headers. This allows the LCD, pushbuttons, LEDs, etc. to be mounted onto a custom front panel. Analog inputs, digital I/O and interlocks are connected via screw terminal blocks. Board dimensions are 200 x 175mm, expected to be 4-6 layers.

Power Requirements

This board requires three voltages: +5V @ 2A, +15V @ 1A, -15V @ 0.5A. If the outputs of the small power supply are isolated, the common terminal should be connected to earth ground at this board.

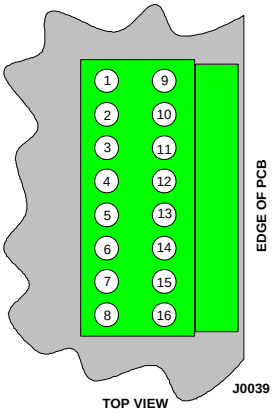
Connector Pinouts

Analog Inputs

ANALOG INPUT J4	
pin	description
1	CH0+
2	CH0-
3	CH1+
4	CH1-
5	CH2+
6	CH2-
7	CH3+
8	CH3-
9	CH4+
10	CH4-
11	CH5+
12	CH5-
13	CH6+
14	CH6-
15	CH7+
16	CH7-

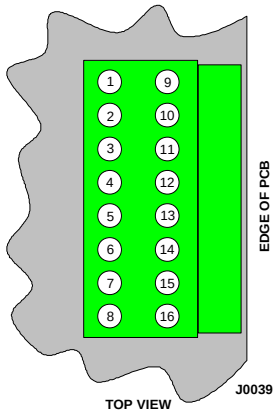
ANALOG INPUT J5	
pin	description
1	CH8+
2	CH8-
3	CH9+
4	CH9-
5	CH10+
6	CH10-
7	CH11+
8	CH11-
9	CH12+
10	CH12-
11	CH13+
12	CH13-
13	CH14+
14	CH14-
15	CH15+
16	CH15-

ANALOG INPUT J6	
pin	description
1	CH16+
2	CH16-
3	CH17+
4	CH17-
5	CH18+
6	CH18-
7	CH19+
8	CH19-
9	CH20+
10	CH20-
11	CH21+
12	CH21-
13	CH22+
14	CH22-
15	CH23+
16	CH23-



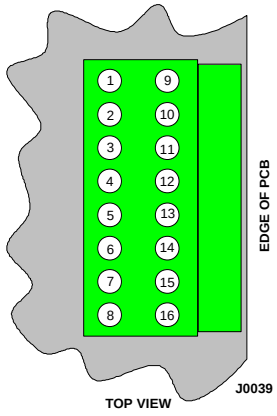
Digital Inputs

DIGITAL INPUT J8	
pin	description
1	D0 anode
2	D0 cath
3	D1 anode
4	D1 cath
5	D2 anode
6	D2 cath
7	D3 anode
8	D3 cath
9	D4 anode
10	D4 cath
11	D5 anode
12	D5 cath
13	D6 anode
14	D6 cath
15	D7 anode
16	D7 cath



Digital Outputs

RELAY OUTPUTS J7	
pin	description
1	OUT0 C
2	OUT0 NC
3	OUT1 C
4	OUT1 NC
5	OUT2 C
6	OUT2 NC
7	OUT3 C
8	OUT3 NC
9	OUT4 C
10	OUT4 NC
11	OUT5 C
12	OUT5 NC
13	OUT6 C
14	OUT6 NC
15	OUT7 C
16	OUT7 NC



Interlocks and AC DIST. ENABLE (J9)

pin	description
1	AC DIST ENABLE+
2	GND
3	EXT INTERLOCK1
4	EXT INTERLOCK1 RETURN
5	EXT INTERLOCK2
6	EXT INTERLOCK2 RETURN

LCD Interface (J15)

pin	description
1	GND
2	+5V
3	VEE
4	RS
5	RW
6	ENABLE
7	DATA0
8	DATA1
9	DATA2
10	DATA3

pin	description
11	DATA4
12	DATA5
13	DATA6
14	DATA7
15	N.C.
16	N.C.
17	LED ANODE
18	LED ANODE
19	LED CATH
20	LED CATH

Local Interface (J14)

pin	description
1	1553 active LED cath
2	1553 active LED anode
3	+5V LED cath
4	+5V LED anode
5	-12V LED cath
6	-12V LED anode
7	+12V LED cath
8	+12V LED anode
9	reset button C
10	reset button NO

pin	description
11	remote/lcl switch C
12	remote/lcl switch NO
13	disable button C
14	disable button NO
15	menu2 button C
16	menu2 button NO
17	menu1 button C
18	menu1 button NO
19	menu0 button C
20	menu0 button NO

JTAG (J10)

pin	description
1	TCK
2	GND
3	TDO
4	+3.3V
5	TMS
9	TDI
10	GND

MICROCONTROLLER ISP (J11)

pin	description
1	PDI
2	+5V
3	TDO
4	GND
5	RESET
6	GND
7	SCK
8	GND
9	PDO
10	GND